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ABSTRACT

This study explored the relationship between students' high school mathematics courses and grades; the affective variables--mathematics anxiety, effectance motivation, and attitude toward success; and performance in the first quarter developmental studies algebra course. The study reports significant differences between males and females on mathematics anxiety and attitude toward success. Regression analysis shows that high school grade point average, the effectance motivation, and grade in algebra II accounted for 21 percent of the variance in first quarter mathematics grade for the total sample (n=208). For males, the effectance motivation, high school grade point average, and Scholastic Aptitude Test (SAT) quantitative score contributed 31 percent of the variance; the grade in algebra II contributed 12 percent of the variance for females. Implications for mathematics educators and for counselors are discussed. A questionnaire for predictors of success in developmental studies mathematics is included in the appendix. (YP)

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Success or Failure: Variables Affecting Mathematics Performance

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Running head: Success or Failure

Abstract

Two hundred students in beginning level developmental studies algebra participated in a study relating three affective variables-mathematics anxiety, attitude toward success, and effectance motivation-high school mathematics preparation, and performance in the class. The relationship between these variables and suggestions for lessening their detrimental effects will be discussed.

Many variables contribute to the success of students in a developmental studies algebra course. If these variables can be identified and then addressed through the curriculum, more students should be able to master the course. This study explored the relationship between students' high school mathematics courses and grades, the affective variables--mathematics anxiety, effectance motivation, and attitude toward success- and performance in the first quarter developmental studies algebra course.

Research suggests that high risk students have unique characteristics that affect their performance; therefore, the authors sought to identify these characteristics and then to lessen the affect of them through intervention strategies in both the mathematics and counseling classes. Like Alexander and Cobb (1984), this research sought to determine the relationship between anxiety and high school mathematics background. Is the lack of course work the main source of variance in classroom performance, or is the student's affective domain as determined by scores on three scales contributing more to his success? The work of Kulm (1980), Fennema and Peterson (1983), and Eccles et al. (1983) which studied the relationship between attitudes, behavior, and other mediating factors on mathematics achievement also influenced this study.

In previous studies conducted with this population, the affective variables, SATQ, and HSGPA accounted for a small percentage of the variance in course grade. It was the purpose of this research to be able to account for more of the variance in class grade, and for this reason a questionnaire included these new questions.

1. During what academic year did you take your last mathematics course?

2. What is the highest level of high school mathematics course you completed?

3. What grade did you earn in Algebra I, Algebra II, and Geometry?

4. What is the highest mathematics course you intend to complete at The University of Georgia?

5. Do you like math?

6. Would you enroll in a college mathematics course if not required to do so?

7. What is your intended major?

8. On the average how many minutes do you spend nightly on your homework?

A copy of the full questionnaire is included in the appendix.

Method

The sample consisted of 208 students (118 females and 90 males) enrolled in a developmental studies program at a large southeastern public university, fall quarter 1988. The instruments used were three of the Mathematics Attitude Scales (Fennema & Sherman, 1976): Mathematics Anxiety (AN), Effectance Motivation (EM), Attitude toward Success in Mathematics (AS), and eleven questions regarding background in mathematics. Each of the scales consisted of 12 items.

Results

Means and standard deviations indicate that significant differences existed between males and females on two of the scales: Mathematics Anxiety, $t(206) = 3.42$, $p < .01$ and Attitude toward Success, $t(183) = 2.76$, $p < .01$. In addition, significant differences existed between gender on the HSGPA and SATQ with females having the larger HSGPA, $t(206) = 5.41$, $p < .01$, and males having a higher SATQ score, $t(163) = 4.54$, $p < .01$.

Separate regression analyses were run for the total sample, male subgroup, and female subgroup. For the total group, results indicated that HSGPA, the Effectance Motivation scale, and grade received in Algebra II accounted for 21 percent of the variance in first quarter mathematics grade, $F(3,173) = 14.92$, $p < .01$. An examination of the MAXR stepwise regression analysis (SAS, 1982) indicated that HSGPA contributed 11 percent; Effectance Motivation, 8 percent; and Algebra II grade, 2 percent.

For males the Effectance Motivation scale, HSGPA, and SATQ contributed 31% of the variance of first quarter mathematics grade $F(3,71) = 10.78$, $p < .01$. The Effectance Motivation scale accounted for 21 percent, HSGPA 5 percent, and SATQ 6 percent.

For females, only the grade received in Algebra II contributed significantly to first quarter grade in mathematics. Algebra II grade accounted for 12 percent of the variance, $F(1,99) = 13.88$, $p < .01$.

Discussion

After teaching high risk students, instructors know that there must be a strong relationship between achievement and motivation, but the authors do not have a good instrument for measuring motivation. Strong motivation to succeed is recognized in some students, and the lack of it is seen in other students, but how to accurately measure it is a problem. As some indication of motivation, the authors anticipated that there would exist a relationship between how much mathematics a student planned to take or his major and course grade. The relationship found between these two variables was not significant. Whether the student would have selected the course if it were required might significantly affect his grade, but this did not appear true. Of these new variables that might be related to motivation, only a student's unqualified response of yes or no to the question, "Do you like math?" affected the variance in grade.

Even though the authors could not account for as much of the variance as anticipated or desired, it was helpful to be able to rule out some variables as contributing strongly towards success in the course. If a study were conducted and the findings were different from those anticipated, examination of the data could give a better understanding of students and suggest curriculum modifications.

Implications for Mathematics Educators

The implications for mathematics educators are varied. Early recognition of remedial factors would allow the use of intervention strategies which should help the students' performance. Math anxiety was significant in previous studies (Goolsby et al., 1988); early identification of math-anxious students enabled educators and counselors to take steps to alleviate the anxiety in this population. Perhaps for this reason, math anxiety was not significant in this study.

Some strategies which may help math anxiety and effectance motivation include:

1) the use of small classes, enabling the teacher and student to work together frequently on a one-to-one basis

2) a math lab with computer and tutors, providing individual instruction and hands-on practice in concepts and skills

3) math journals, stimulating writing in math and encouraging students to verbalize thought processes in problem-solving, analyze study skills and express feelings

4) a greater amount of time spent by the instructor in encouraging, building positive attitudes, and stressing persistance, self-confidence and math assertiveness.

Implications for Counselors

The findings of this study differed from those of previous research done by the authors in which mathematics anxiety was consistently a significant variable in the regression analyses. Rather than assuming that mathematics anxiety may not be an issue for this sample, it is more likely that both the counselors and mathematics educators working with this targeted population have been successful in improving their efforts to combat anxiety. All students enrolling in this university's Developmental Studies program are required to participate in a counseling course which meets two hours a week for two credits. Even before instruments are administered to assess test and math anxiety the counselors introduce a wide variety of stress reduction techniques, including relaxation training, visual imagery, and cognitive restructuring.

Neither males nor females in this sample have very high attitude toward success scores. Although not a significant variable in the regression analysis for this sample, the attitude toward success variable did make a significant contribution to variance in first quarter grades in a previous study (Dwinell & Higbee, 1989). Since mathematics may serve as a critical filter in career selection (Sells, 1980), the negative attitude toward success displayed by the sample is unfortunate. Counselors can assist students in understanding mathematics requirements for a wide variety of majors and can also encourage success.

Effectance motivation proved to be a significant variable in predicting first quarter mathematics grade for both females and males in this sample. Students who are more involved in learning for learning's sake performed significantly better during their first quarter in Developmental Studies mathematics. One function of the counseling component of any program for high risk students should be to help students develop a desire to learn. For students in this Developmental Studies program reasons for attending college are more closely related to career development than gaining knowledge or personal growth. When assisting students in establishing educational goals and objectives it is imperative that counselors help students explore how they feel about learning. It is not surprising, given the past experiences which resulted in their enrollment in Developmental Studies, that many of the students in this population focus more on the outcomes of attending college rather than the process of learning. They may enjoy being at

college, but they do not necessarily find the same enjoyment in attending classes, doing homework, and studying for exams, nor are they likely to engage in learning anything beyond what is required. In Achieving Educational Excellence Alexander Astin (1985) promotes the concept of involvement. Developmental Studies students may have more opportunities for involvement with faculty due to the smaller class size and more individualized instructional methods inherent in the program. However, they are not likely to be as involved in learning when compared with other freshmen.

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Table 1

Means and Standard Deviations

	Females n = 118		Males n = 90	
	M	SD	M	SD
*Mathematics Anxiety	40.77	11.42	35.88	8.43
*Attitude toward Success	17.90	5.21	20.02	5.69
Effectance Motivation	35.25	8.73	33.88	8.08
*High School GPA	2.80	.42	2.47	.45
*SATQ	412	46.02	445	57.23

*Significant difference between males and females at the .01 level.

Table 2

Mathematics Background, Mathematic Attitude, HSGPA, and SAT Quanitative Score

Results of Regression Analysis

	Variable	R^2	R^2	df	F	p
Females	Algebra II grade	.1229		1,99	13.88	.0003
Males	EM	.2073		1,73	19.09	.0001
	HSGPA	.2559	.0486	2,72	12.35	.0001
	SATQ	.3129	.0570	3,71	10.78	.0001
Total	HSGPA	.1058		1,174	20.60	.0001
	EM	.1835	.0777	2,173	19.44	.0001
	Algebra II grade	.2064	.0229	3,172	14.92	.0001

Predictors of Success in Developmental Studies Mathematics

Your responses to the following questions will be used to help determine what factors are related to success in a Developmental Studies mathematics course. Please respond on your answer sheet according to the following scale:

A	B	C	D	E
Strongly Agree	Somewhat Agree	Undecided	Somewhat Disagree	Strongly Disagree

1. I like math puzzles.
2. Math doesn't scare me at all.
3. It would make me happy to be recognized as an excellent student in mathematics.
4. A math test would scare me.
5. I do as little work in math as possible.
6. Being regarded as smart in mathematics would be a great thing.
7. Math puzzles are boring.
8. I almost never have gotten shook up during a math test.
9. Mathematics is enjoyable and stimulating to me.
10. I get a sinking feeling when I think of trying hard math problems.
11. People would think I was some kind of a grind if I got A's in math.
12. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.
13. It wouldn't bother me at all to take more math courses.
14. I am challenged by math problems I can't understand immediately.
15. It would make people like me less if I were a really good math student.
16. I usually have been at ease in math classes.
17. If I had good grades in math, I would try to hide it.

18. Once I start trying to work on a math puzzle, I find it hard to stop.

19. It would be really great to win a prize in mathematics.

20. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

21. When a question is left unanswered in math class, I continue to think about it afterward.

22. Mathematics makes me feel uneasy and confused.

23. I'd be happy to get top grades in mathematics.

24. The challenge of math problems does not appeal to me.

25. Winning a prize in mathematics would make me feel unpleasantly conspicuous.

26. I haven't usually worried about being able to solve math problems.

27. If I got the highest grade in math I'd prefer no one knew.

28. Mathematics usually makes me feel uncomfortable and nervous.

29. I don't understand how some people can spend so much time on math and seem to enjoy it.

30. I'd be proud to be the outstanding student in math.

31. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

32. My mind goes blank and I am unable to think clearly when working mathematics.

33. I don't like people to think I'm smart in math.

34. I usually have been at ease during math tests.

35. Figuring out mathematical problems does not appeal to me.

36. Being first in a mathematics competition would make me pleased.

37. During what academic year did you take your last mathematics course?
    a. 1987-88 (last year)
    b. 1986-87
    c. 1985-86
    d. 1984-85 or before

38. What is the highest level of high school mathematics course you completed?
    a. Calculus
    b. Pre-calculus
    c. Algebra II/Trigonometry
    d. Geometry
    e. Algebra I

39. What grade did you earn in Algebra I?
    a. A
    b. B
    c. C
    d. D
    e. F

40. What grade did you earn in Geometry?
    a. A
    b. B
    c. C
    d. D
    e. F

41. What grade did you earn in Algebra II? (Leave this question blank on your answer sheet if you did not complete Algebra II.)
    a. A
    b. B
    c. C
    d. D
    e. F

42. What was the highest score you achieved on the quantitative section of the SAT?
    a. 500 or above
    b. 450-490
    c. 400-440
    d. 350-390
    e. 340 or below

43. What is the highest mathematics course you intend to complete at the University of Georgia?
    a. MAT 102: Basic Algebra
    b. MAT 105, 106: Introduction to Mathematics, or MAT 109: Trigonometry
    c. MAT 116: Pre-Calculus
    d. MAT 205, 206: Mathematics for Elementary Teachers
    e. MAT 253: Calculus, or higher (e.g., MAT 254, 255)

44. Do you like math?
    a. yes
    b. no

45. Would you enroll in a college mathematics course if not required to do so?
    a. Yes
    b. No

46. What is your intended major?
    a. Math, math ed, science, statistics, computer science, pre-med, pre-vet, pre-pharmacy, or other scientific area of study
    b. Business
    c. Social sciences, arts, humanities, journalism, social work, agriculture, home economics
    d. Education (other than math ed.)
    e. Undecided

47. On the average how many minutes do you spend nightly on your homework?
    a. 0-20 min.
    b. 21-40 min.
    c. 41-60 min.
    d. between 1 hour and 1 1/2 hours
    e. over 1 1/2 hours